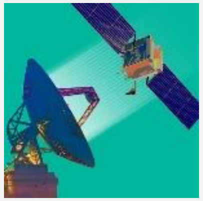

GSAW 2017
March 13-16, 2017
Renaissance Los Angeles Airport Hotel
Session 4: Data Analytics

Creative Analytics of Mission Ops Event Messages

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Events/Log Analysis - Theory

- 2016/101:13:34:05.34 ORB Entering Eclipse. Duration = 12:34.000

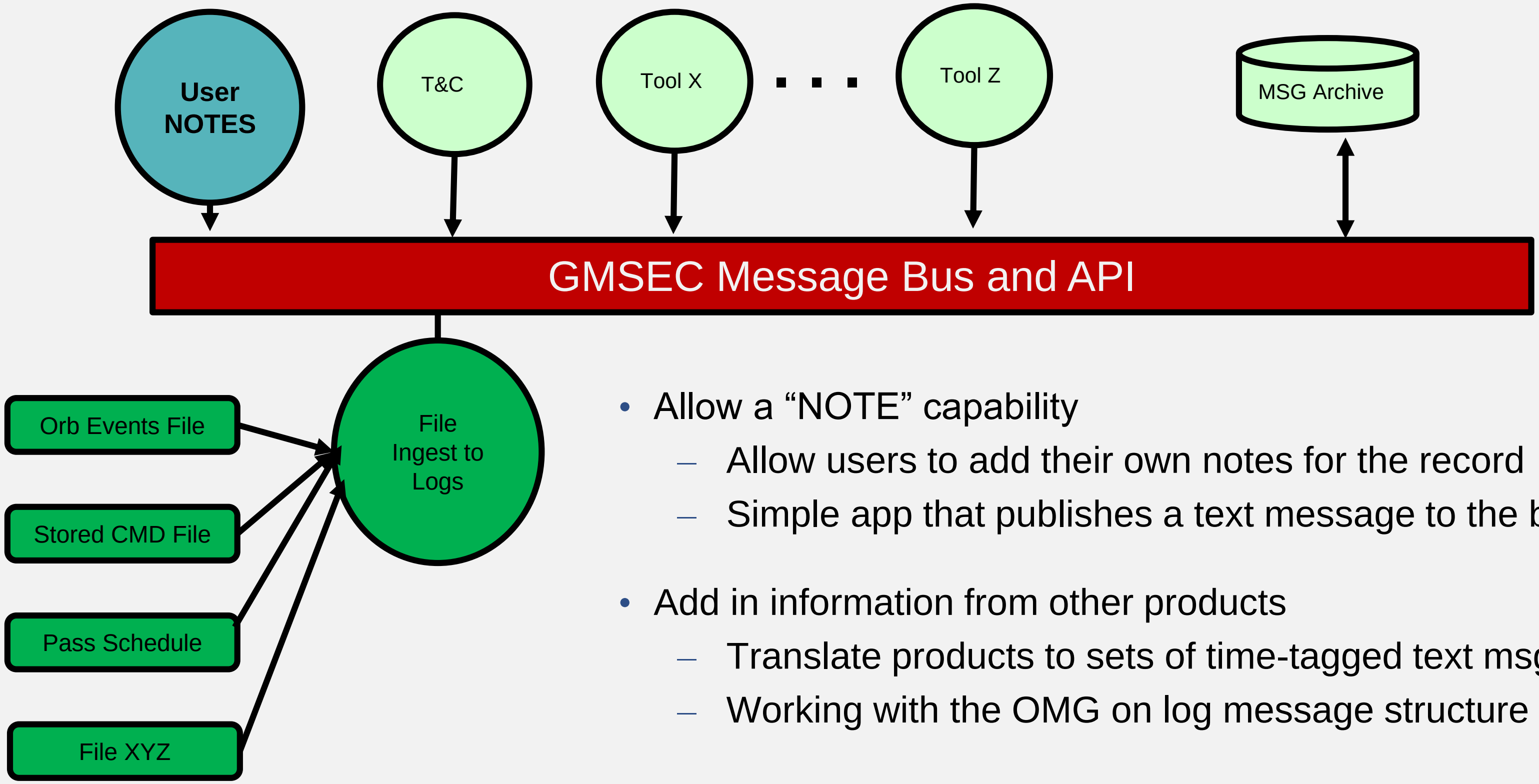
- Historically, we have put tremendous effort into processing and displaying housekeeping telemetry.
  - We convert it, combine it, limit-check it, plot it, and trend it. We even draw dials and thermometers.

- Events/Log messages have received much less attention
    - Once a message scrolls off the screen, we often never see it again
    - Limited use for automation and for notifying team of issues via email or texting
    - Logs are often in each local system and not viewed together
    - Perl scripts sometimes developed to help analyze the logs
  - It is the logs that know when commands were resent, when there were data drop outs or system failures, when people log on and off, and much much more.

- What could we do better?
  - Bring together the logs of multiple systems to increase situational awareness
  - Express many of our non-telemetry items as event/log messages
  - Create new display and analysis tools to provide powerful new situational awareness and operations support capabilities

First, let's collect the information

- Combine existing logs
  - With GMSEC open pub/sub architecture, components each publish their event messages and a single archive can be created



- Allow a "NOTE" capability
  - Allow users to add their own notes for the record
  - Simple app that publishes a text message to the bus
- Add in information from other products
  - Translate products to sets of time-tagged text msgs
  - Working with the OMG on log message structure standard

Great News: Now we have lots and lots of time-tagged text data to work with!

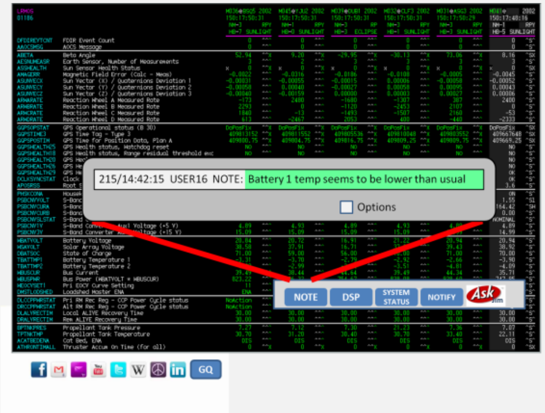
Now we have a problem!

- Some missions may have 50,000 or more messages per day!
- With new levels of automation, there may not even be any operators on-console to watch displays
- As we move towards constellations and enterprise systems, we will be mixing satellites in the same logs
- **Out of sight → Out of mind**

If we have a huge message log, but nobody can use it,
do we even have a message log?

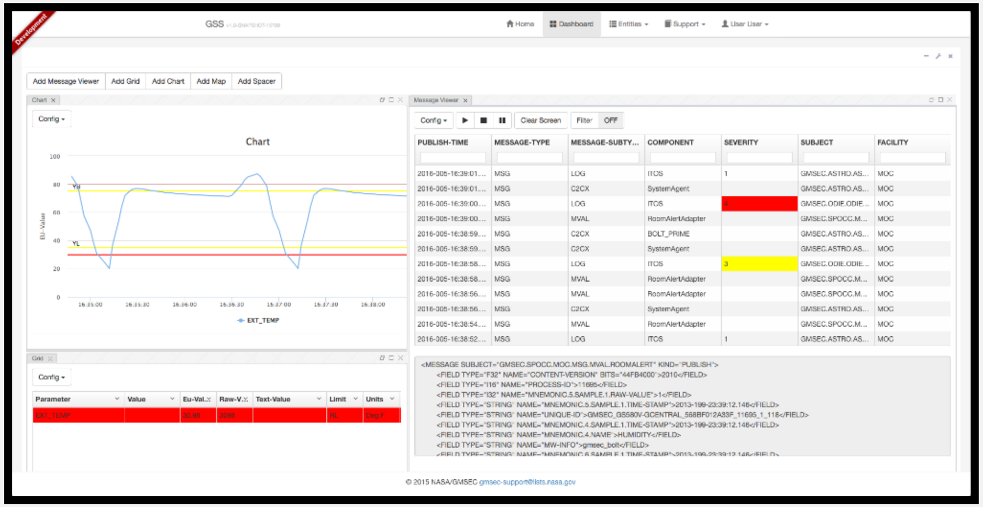
How can we display 1,000’s of messages?

- Enhanced message log display – similar to today’s capabilities
  - Simplify the dynamic filters for the users
  - Enable color coding of message fields, not just of entire line



215/14:42:15 USER16 NOTE: Battery 1 temp seems to be lower than usual

☐ Options



PUBLISH-TIME	MESSAGE-TYPE	MESSAGE-SUBTY...	COMPONENT	SEVERITY	SUBJECT	FACILITY
2016-005-16:39:01....	MSG	LOG	ITOS	1	GMSEC.ASTRO.AS...	MOC
2016-005-16:39:01....	MSG	C2CX	SystemAgent		GMSEC.ASTRO.AS...	MOC
2016-005-16:39:00....	MSG	LOG	ITOS	4	GMSEC.ODIE.ODIE...	MOC
2016-005-16:39:00....	MSG	MVAL	RoomAlertAdapter		GMSEC.SPOCC.M...	MOC
2016-005-16:38:59....	MSG	C2CX	BOLT_PRIME		GMSEC.ASTRO.AS...	MOC
2016-005-16:38:59....	MSG	C2CX	SystemAgent		GMSEC.ASTRO.AS...	MOC
2016-005-16:38:58....	MSG	LOG	ITOS	3	GMSEC.ODIE.ODIE...	MOC
2016-005-16:38:58....	MSG	MVAL	RoomAlertAdapter		GMSEC.SPOCC.M...	MOC
2016-005-16:38:56....	MSG	MVAL	RoomAlertAdapter		GMSEC.SPOCC.M...	MOC
2016-005-16:38:56....	MSG	C2CX	SystemAgent		GMSEC.ASTRO.AS...	MOC
2016-005-16:38:54....	MSG	MVAL	RoomAlertAdapter		GMSEC.SPOCC.M...	MOC
2016-005-16:38:52....	MSG	LOG	ITOS	1	GMSEC.ASTRO.AS...	MOC

```
<MESSAGE SUBJECT="GMSEC.SPOCC.MOC.MSG.MVAL.ROOMALERT" KIND="PUBLISH">
    <FIELD TYPE="F32" NAME="CONTENT-VERSION" BITS="44FB4000">2010</FIELD>
    <FIELD TYPE="I16" NAME="PROCESS-ID">11695</FIELD>
    <FIELD TYPE="I32" NAME="MNEMONIC.5.SAMPLE.1.RAW-VALUE">1</FIELD>
    <FIELD TYPE="STRING" NAME="MNEMONIC.5.SAMPLE.1.TIME-STAMP">2013-199-23:39:12.146</FIELD>
    <FIELD TYPE="STRING" NAME="UNIQUE-ID">GMSEC_GS580V-GCENTRAL_568BF012A33F_11695_1_118</FIELD>
    <FIELD TYPE="STRING" NAME="MNEMONIC.4.SAMPLE.1.TIME-STAMP">2013-199-23:39:12.146</FIELD>
    <FIELD TYPE="STRING" NAME="MNEMONIC.4.NAME">HUMIDITY</FIELD>
    <FIELD TYPE="STRING" NAME="MW-INFO">gmsec_bolt</FIELD>
    <FIELD TYPE="STRING" NAME="MNEMONIC.6.SAMPLE.1.TIME-STAMP">2013-199-23:39:12.146</FIELD>
```

Parameter	Value	Eu-Val...	Raw-V...	Text-Value	Limit	Units
EXT_TEMP		30.98	3098		RL	Deg F

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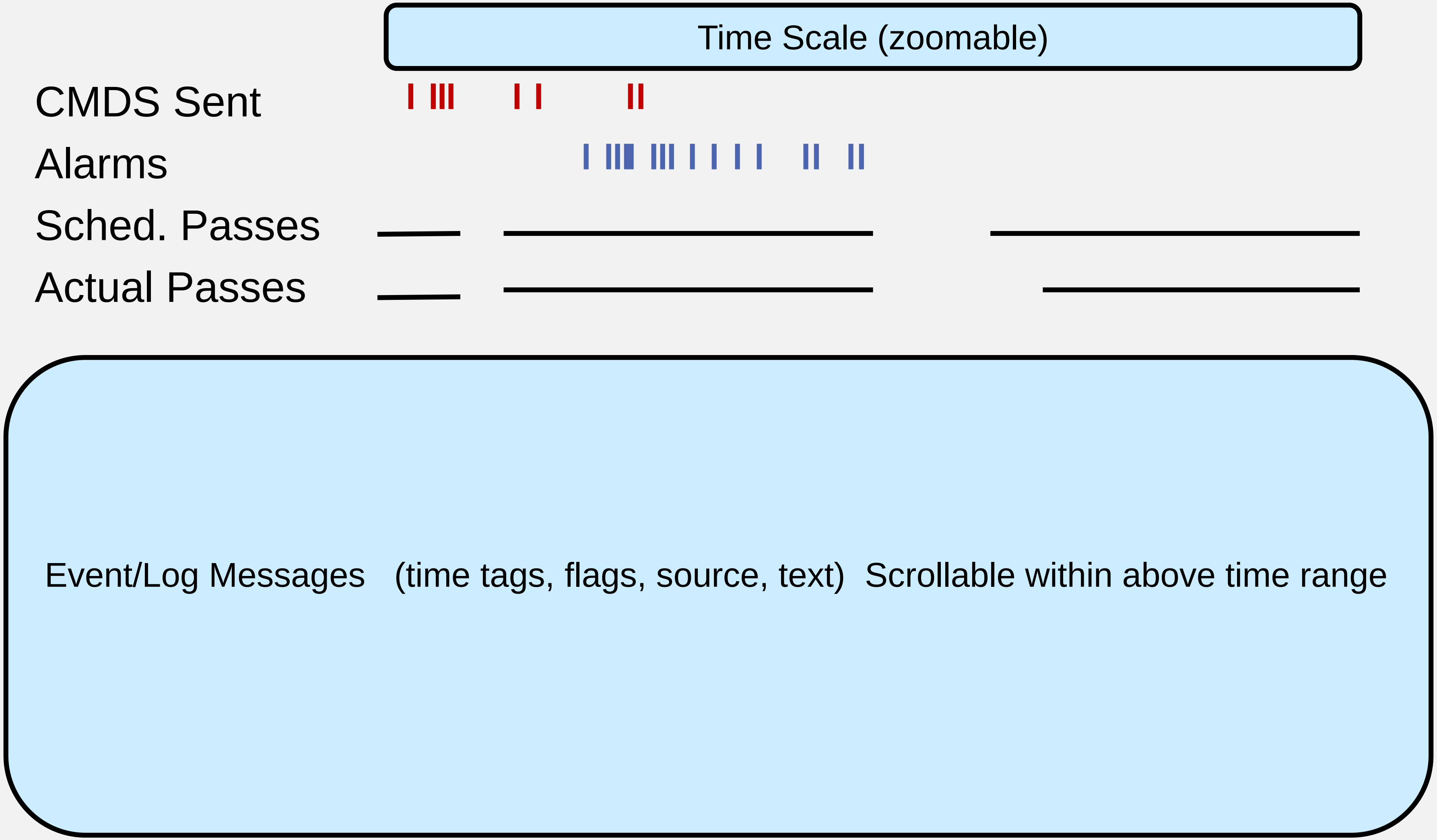
- “Ticks and Bars” Display
  - User defines the lines of the display
  - TICK, Title = “COMMANDS SENT”, Find = “/CMD”
    - Display will show a small mark on a time scale for each command sent
  - BAR, Title = “ECLIPSE”, Start = “Eclipse Entry”, End = “Eclipse exit”
    - Display will show a bar on a time scale depicting eclipse period
  - Zoomable time scale; event message viewer at bottom of display

Ticks and Bars Display Capability



Time Scale (zoomable)

CMDS Sent

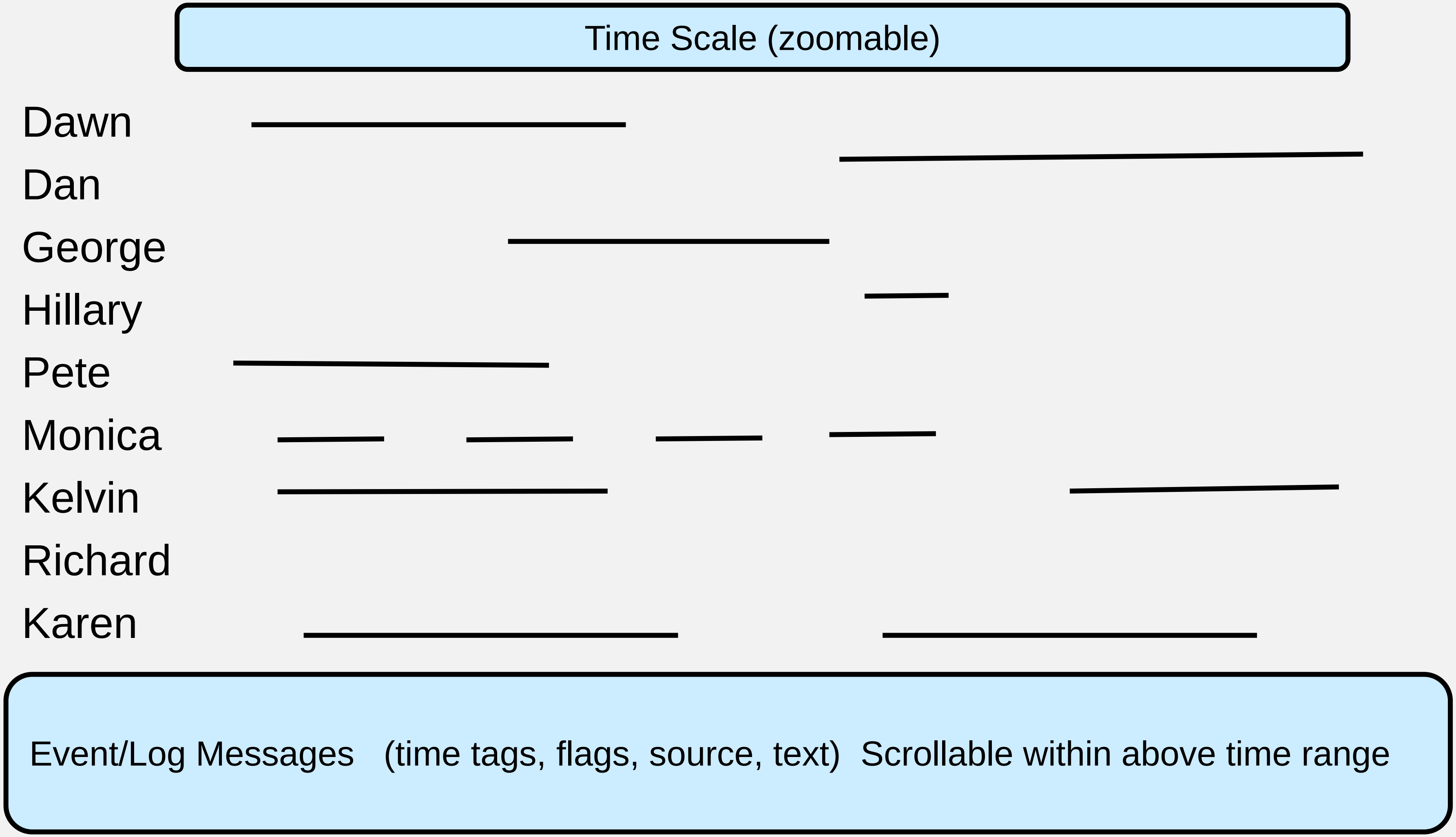
Alarms

Sched. Passes

Actual Passes

Event/Log Messages (time tags, flags, source, text) Scrollable within above time range

Ticks and Bars Display – Team Staffing



Time Scale (zoomable)

Dawn

Dan

George

Hillary

Pete

Monica

Kelvin

Richard

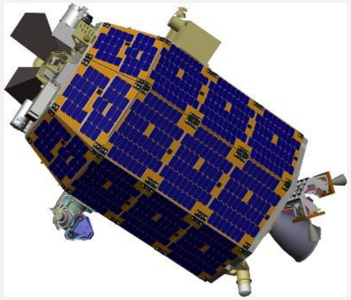
Karen

Event/Log Messages (time tags, flags, source, text) Scrollable within above time range

What can we learn from 1,000’s of messages?

- “Ask Jim” – Query Capabilities
  - Structured language to allow for smart searching of the events logs.
  - Key words or phrases: How many . . ., When did . . ., For how long, …
  - Key time words: TODAY, YESTERDAY, etc.
  - Response could be an English sentence response or a set of messages.
- User specifies enough information to find the needed messages
  - Time span, text-match information
- Tool can FIND, COUNT and COMPUTE-DURATION
- Could have FAQs and user-defined keywords to simplify user input
- Sample Queries
  - QUESTION: How many commands did we send today?
  - RESPONSE: As of 18:30 today, 237 commands have been sent
  - QUESTION: When did we send command HEATER_1A_ON?
  - RESPONSE: Command HEATER_1A_ON was last sent on Day 63 at 13:42:05

Let’s get more advanced



- Event-based automation (already available)
- More sophisticated queries
  - Compound queries
  - Ability to exclude certain messages
- Auto-generation of shift/status reports based on event message analysis
- Text-Based Data Analytics
  - Discover/learn trends or sequence “signatures”
  - Cross-vehicle assessment

- Move to natural language interface
  - Allow broader search ability
  - Support voice recognition
- Create a Ops Assistant
  - Imagine an Amazon Echo for each ops position
  - What would the conversation be?
- Access to telemetry values and event messages could be seamless, allowing queries, reports, and displays to easily intermix the two
  - Time frame on plots could be based on query to event log (ie. Plot parameters x, y, and z for the last orbit, or for when John was logged on yesterday.

Summary

- We think that the set of events/log message enhancements will provide powerful capabilities for the mission user regardless of Agency or type of mission

- Placing an emphasis on non-telemetry analysis opens up a new area of data mining, analytics and tool development – we think the users will help identify even more functions

- This is a great set of applications for mission operations, especially using the GMSEC architecture– the tools will work regardless of what other products are part of the configuration; it works by monitoring traffic on the bus; and is not reliant on any specific vendor products.

Over the Horizon . . .

Could combine event message analysis and analytics with personal “Amazon Echo-style” assistant with virtual reality view of the vehicle showing sun angles/shadows, instrument pointing, temperature readings, etc.

Clipart courtesy of pixabay.com public domain images.

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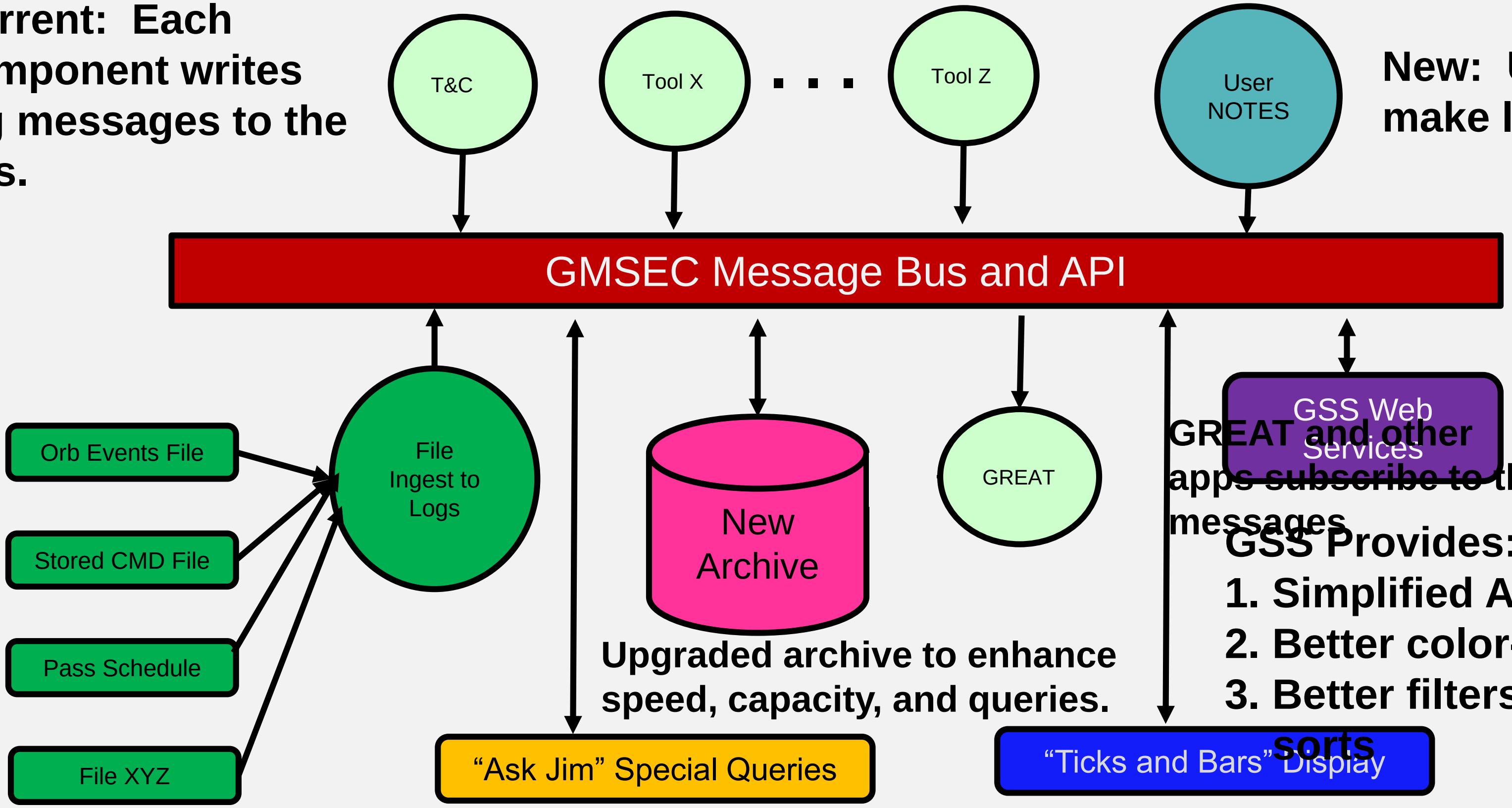
Questions?

GMSEC Log Msg Approach

Current: Each component writes log messages to the bus.

New: Users can make log entries



GREAT and other apps subscribe to the messages

GSS Provides:
1. Simplified Access
2. Better color-coding
3. Better filters and sorts

Upgraded archive to enhance speed, capacity, and queries.

Converting file contents to event messages creates a single integrated log to help increase situational awareness.

Structured English query of the events log file.

User-defined graphical time-based display of selected events.

If I could really change things . . .

- I would make event messages more like e-mail
  - We learned long ago that simply having a time, a source and some flags, and some text [subject] was not enough to convey a message
  - Imagine if we could have optional body text to explain a problem in detail
    - Like the body of email messages
    - Could provide details on a parameter when it goes out of limits
    - Could include the full text of a rule that is violated
  - Imagine if we could have attachments
    - Could capture a screen image when a problem is noted
    - Could include a script that might help get out of a problem